998 Issued May 25, 1907.

U. S. DEPARTMENT OF AGRICULTURE.

FARMERS' BULLETIN 293.

USE OF FRUIT AS FOOD.

BY

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WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1907.

LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
OFFICE OF EXPERIMENT STATIONS,
Washington, D. C., April 11, 1907.

SIR: I have the honor to transmit herewith, and to recommend for publication as Farmers' Bulletin No. 293, an article on the use of fruit as food, prepared by C. F. Langworthy, in charge of nutrition investigations of this Office, in accordance with instructions given by the Director.

The present bulletin is a revision and extension of an article by Doctor Langworthy bearing a similar title, which was published in the Yearbook of the Department for 1905, and constitutes a summary of available data on the composition, food value, and place in the diet of fresh and preserved fruits of different sorts, particularly the fruits of temperate regions which are commonly grown in the United States. In preparing the bulletin an extended study has been made of the literature of the subject, especially of the numerous investigations reported by the agricultural experiment stations and the widely scattered articles in American and foreign journals. The present bulletin is therefore similar in scope and purpose to the popular publications which the Department has issued in the past summarizing available information on different food materials which enter largely into the diet of most American families.

Respectfully,

A. C. TRUE,
Director.

Hon. JAMES WILSON,
Secretary of Agriculture.

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USE OF FRUIT AS FOOD.

INTRODUCTION.

Edible fruits show the greatest range in form, color, and appearance and are found in almost countless varieties; yet from the botanist's standpoint all our fruits are the seed-bearing portion of the plant. The edible fruits of temperate regions fall into a few groups—stone fruits, like cherries and plums; pome fruits, like apples and pears; grapes; and berries, like strawberries, blackberries, and currants. There are several products, such as muskmelons, cantaloupes, and watermelons, sometimes classed as fruits and sometimes as vegetables, which, of course, would not belong to any one of these groups. Tropical fruits are not so easily classified, though the citrus family (oranges, lemons, etc.) includes many of the more common sorts.

There are a few vegetable products which are not fruits in any botanical sense, but which by common consent are included in this class of food products since their place in the diet is the same. The most common of these products is rhubarb, and there are few uses of fruit which the acid rhubarb stalk does not serve. Angelica stalks, which are candied and used for making cakes and confectionery, are much less common, though the total amount used is large. It is certainly more natural to include preserved, candied, and crystallized ginger root with candied pineapple, candied cumquats and similar products than with any other class of food materials, and old-fashioned candied sweet flag root may also be mentioned in this connection.

WILD AND CULTIVATED FRUITS.

In an account of the first Virginia colony it is stated that the Indians ate wild mulberries, crab apples, and huckleberries, but nothing is said of their cultivating fruits, though they raised corn and other vegetables. Wild fruits have been part of the diet of primitive man whenever obtainable, and no one can say with certainty when wild varieties were first cultivated, but it must have been early in the history of the race, since such fruits as apples and pears have been under cultivation so long that the varieties now grown have scarcely any resemblance to the very small, woody, inferior fruit of the wild parent. As a country becomes more thickly settled, less and less reliance can be placed on wild fruits, and the market gardener

and fruit grower become of increasing importance. In the United States, strawberries, blackberries, and raspberries are examples of fruits which are still eaten both wild and cultivated, and cranberries have so recently come under cultivation that many persons still think of them as a wild fruit. Huckleberries and blueberries are practically unknown, except as they grow wild, though attempts are now being made to bring the blueberry to greater perfection under cultivation. Among little-known wild fruits elderberries and scarlet haws or thorn apples, to give them their New England name, may be mentioned. Both are used for jelly making to some extent and the former for other purposes also, but as yet neither is considered as of much importance.

It would be difficult to say why some fruits which are considered to be fairly palatable and equal to others which are generally eaten have obtained so little popularity. For instance, both wild and cultivated mulberries have long been known and prized by many, but are perhaps unknown to the majority of persons and very little used. In the same way the medlar, a fruit closely related to the apple and common enough in parts of Europe, is almost unknown in the United States, though it could be readily grown, if desired.

In some of our cultivated fruits, like the banana, seed is almost never found; in the case of others, for instance the orange, the seedless and seed-bearing varieties are both common; but in the majority of fruits seeds are present in greater or less abundance. It has been said that seedlessness is a result of long-continued cultivation, but it seems more probable that the seedless forms are due to the propagation and cultivation of natural sports without seeds. Seedless sports are by no means uncommon in wild fruits. Thus the native American persimmon is now and then found bearing seedless fruit, and such a form could be perpetuated by horticulturists, if need be. The seedless navel orange has been propagated in recent times from a seedless sport, and it seems very probable that bananas, though the wild forms are commonly full of seeds, were propagated from a seedless sport in times too remote for record. Indeed, it may be said that there is an almost universal tendency to cultivate and perpetuate varieties in which seeds are few in number or small in size, and quite naturally, since such fruits are more convenient to use and contain a higher proportion of nutritive material in a given bulk.

In general, it is true that size, yield, color, flavor, texture, and chemical composition are modified by cultivation.

The commercial fruit grower, of course, desires a fruit of good appearance, having satisfactory shipping and keeping qualities, and too often the consumer is satisfied to accept a product in which such qualities predominate. Discriminating purchasers, however, will

insist on good flavor, texture, and cooking qualities as well, and such demands should be more often urged in order that quality may replace appearance as a standard in cultivating fruit for market.

MARKET CONDITIONS AND FRUIT SUPPLY.

The fruit market has been very greatly modified and extended by improved methods of transportation and storage. A man need not be very old to remember the time when, at least in the Northern States, bananas were a comparative rarity outside the large cities, and oranges and lemons, though common commodities, were rather high in price. In the summer there was an abundance of the common garden fruits, but in winter apples were practically the only sort which was at all plentiful. A few years have witnessed a great change, and now there is hardly a village so small that bananas and other southern fruits can not be purchased at reasonable prices. In Europe the situation is much the same. Such quantities of bananas are now taken to England and sold at such reasonable rates that they are sometimes spoken of there as the poor man's fruit. At the present time there are a number of fruits, such as avocados or "alligator pears," mangoes, and sapodillas, which are fairly well known in our large markets though seldom seen in the smaller towns. The enormous development of the fruit-growing industry in California and Florida, which includes the products of both temperate and warm regions, as well as the possibilities of supplying the northern markets with tropical fruits from Porto Rico and Hawaii, makes it probable that within a few years the avocado, the mango, and other tropical fruits will be as well known as the pomelo or the pineapple.

Improvements in transportation have also materially lengthened the season of many fruits, such as strawberries, which can not be stored for any considerable period. Florida and the Carolinas now send their berries to northern markets months before the home-grown crop can be expected and several weeks before that from tidewater Virginia or New Jersey is ripe. As an illustration of the effect of improved methods in shipping fruit, it may be mentioned that melons from the south of France, hothouse peaches from Belgium, and peaches, plums, and other fruits from South Africa are now sent to our American markets in winter. The introduction or origination of new varieties of fruits also prolongs the season. As an instance may be cited the Peen-to peach, a Chinese variety which can be successfully raised in Florida and Texas, and which is found in our northern markets in early spring, though at present at prices which clearly make it a luxury. Furthermore, improved methods of culture and transportation have extended the area planted to old and well-known varieties.

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COLOR AND FLAVOR OF FRUITS.

Fruits, like leaves and flowers, owe their varied color to a number of chemical compounds, the green to chlorophyll (the characteristic coloring matter of green leaves), the yellow to xanthin bodies and other yellow pigments, and the blue and red to solutions in the cell sap of complex coloring matters which have in most cases been isolated and classified. Several coloring matters are often present in combination and give rise to the great variety of shades which different fruits present. In white fruits coloring matter is absent from the epidermis and the cells are said to be filled with air. As fruits develop, mature, and deteriorate, the coloring matters present undergo marked chemical changes, and color is one of the most common means of judging of ripeness.

Attractive color has a decided effect on market value, and the public demand varies greatly in different regions. Thus, a yellow or russet dessert apple is demanded in the French market, while in many parts of the United States the red apple has the preference. A faded, dull color is often an indication of staleness; strawberries and raspberries which have been kept too long have little of the brilliant color of freshly gathered fruit. That fruit colors in general are not very permanent is shown by the way the color deteriorates on long-continued cooking or fades when canned and preserved fruits are exposed to the light.

In preparing such fruits as plums, peaches, etc., for the table, the skin may be readily removed, without injury to the flavor by first immersing them for a short time in boiling hot water. A silver knife should always be used for paring apples, pears, and other fruits, as if a steel knife is used the acid of the fruit acts on the iron of the knife and frequently causes a black discoloration, and there is also very commonly a noticeable metallic flavor. If pared or cut fruit is exposed to the air, it rapidly turns dark in color, owing to the action of oxydases, as some of the ferments normally present in fruits are called, upon the tannin or other readily oxidizable bodies which are also normal fruit constituents.

In the same way the brown color of the bruised spots in apples is caused by oxidation by means of the oxydases present in the fruit of the tannin in the crushed cells. Such bruised portions contain a larger proportion of starch than the rest of the apple because the tannin hinders the transformation of starch into sugar.

In investigations carried on at the Oregon Agricultural Experiment Station with a view to preventing the discoloration of evaporated fruits and vegetables it was found that treating sliced apples with a weak solution of common salt (1 to 2 per cent) resulted in a product which was very bright and white and of better appearance than that

obtained by the well-known domestic method of treatment with cold water. It seems probable that the Oregon method may find application in the household.

Fruits owe their flavor in considerable degree to the sugars and the malic, citric, and other acids which they contain, but the flavor which is so characteristic of different kinds is almost entirely due to ethereal bodies. The amount present is often too small for determination by the usual chemical methods. However, in many cases these flavor-giving bodies have been studied and their chemical nature is known.

The flavor of strawberries has been shown to be dependent in part at least upon the presence of a volatile oil with pronounced strawberry odor which is found in small proportions in the extracted fat of the dried berries. Recent German investigators[a] have identified the compound ethers which give bananas their characteristic flavor.

With the orange and other citrus fruits the oil found in the skin has a very characteristic odor and flavor which are always associated in our minds with the flavor of the fruit. Obviously, the small amount of these bodies of pronounced odor and flavor can not materially modify the nutritive value of fruits, but they are of great importance in considering the place of fruit in the diet, as they are very largely responsible for its attractiveness and palatability. There is no doubt that we all eat more readily the foods which please our palate than those which are of indifferent flavor, and there is every reason to believe that the foods which please are actually digested more easily than those which do not, since they stimulate a normal and abundant production of digestive juices.

COMPOSITION OF FRUITS.

Determining the proportion of water, protein, fat, carbohydrates (nitrogen-free extract and crude fiber), and ash in fruits as in other foods furnishes a convenient basis for judging of their relative food value. It is quite common for chemists to determine, instead of their proximate constituents, the proportions of the different nitrogenous bodies present, as well as the amounts of the different sugars, etc., which in the ordinary method of analysis are grouped with the other carbohydrates.

The more detailed analyses are of great interest and value for many reasons, but with our present knowledge it seems fair to assume that the various sugars and starches, for instance, have the same nutritive value, and so a knowledge of the total quantity of these bodies present gives very satisfactory data for estimating the food value of the group.[b] Very many analyses and studies of fruit and fruit prod-

[a] Deut. Essigindus., 1905, p. 81.

[b] An extended summary of the more detailed analyses of fruits and fruit products may be found in König's Chemie der menschlichen Nahrungs- und Genussmittel. Berlin, 1903, vol. 1, 4th ed., pp. 820–895.

ucts have been made by chemists of the agricultural experiment stations, as well as by the different Bureaus of the Department of Agriculture. Table 1 summarizes a large amount of such data and shows the composition of fresh, dried, and preserved fruits and fruit products, and for comparison the composition of a few other foods as well. In this table and the discussions which follow, attention has been given especially to the fruit of northern and temperate regions and no attempt has been made to summarize the considerable amount of data available regarding tropical fruits, except some which are grown in the United States or which are fairly well known at least in the larger markets. Special studies of tropical fruits have been made by the California and by the Maine experiment stations, and the Bureau of Chemistry [a] of this Department has reported an extended series of investigations of such fruits and the jams and preserves made from them.

Most of the fruits and fruit products included in the table are too well known to need description. Of those which are less familiar, the avocado or "alligator pear" is a green or purple fruit not unlike an eggplant in appearance. The portion eaten is the pulp which surrounds the single large seed. In texture it is soft and somewhat like butter, and to this quality it doubtless owes the name "midshipmen's butter," given to it in the days of sailing vessels. The avocado is eaten in a variety of ways, but is most commonly served as a salad. This fruit has a delicate almost nut-like flavor, and is every year becoming more popular. Earlier publications [b] of this Department have discussed the avocado at length and described its cultivation and uses.

The fruits of several sorts of cactus are very commonly eaten in Mexico and other regions where cactus is abundant, and are common though less well known in New Mexico and the Southwest. Under the name of prickly pear or Indian fig fresh cactus fruits, particularly the oblong, oval, yellowish or reddish fruits of *Opuntia ficus indica*, showing here and there characteristic tufts of fine spines or bristles, are occasionally seen at certain seasons of the year in large fruit shops. Cactus fruits may be used for jam making and in similar ways. A rather hard solid preserve or "cactus cheese," which may sometimes contain nuts, is a Mexican sweetmeat.

Many varieties of the guava, a very aromatic tropical and subtropical fruit, are grown in the warmer regions of the United States, and its uses are so varied that it is often said the guava occupies much the same place in cookery in the Tropics as the apple in northern

[a] U. S. Dept. Agr., Bureau of Chemistry Bul. 87.

[b] U. S. Dept. Agr., Bureau of Plant Industry Bul. 77; Farmers' Bul. 169.

regions. The fresh fruit is seldom seen outside the regions where it is grown, but guava jelly and guava paste are common commercial products, and have been popular ever since the days when the West India merchantmen brought these delicacies, preserved tamarinds, and oranges and lemons to our northern markets as well as such staple goods as sugar and molasses.

The roselle or Jamaica sorrel is the fruit of a widely distributed tropical hibiscus which is grown extensively in California and Florida. The fruits somewhat resemble okra in form, are of a dark magenta color, and have an acid flavor much like that of cranberries. They are used for jams, jellies, etc.

The Surinam cherry is the fruit of a South American tropical shrub now grown to a limited extent in southern Florida and California. It is about the size and shape of an ordinary cherry, and owes its common English name to this fact. The fruit is bright red in color, and has a sharp but pleasant acid flavor. The Surinam cherry is used for jelly making, etc., but is seldom a commercial product.

The loquat, commonly though incorrectly called the Japan plum, is grown to a considerable extent in the southern United States. The small, yellowish, plum-like fruits are almost translucent when ripe, and are covered with a downy fuzz or bloom. The pulp is soft and tender and quite tart until fully ripe. The flavor is distinct and agreeable. Loquats are used both raw and cooked, and both fresh and preserved fruits are commercial products.

The sapodilla, a tropical fruit which thrives in regions like the warmer parts of Florida, suggests a good sized russet apple in appearance, but when broken open is quite different in character, as it contains a number of rather large flat brown seeds embodied in a tender brownish white pulp. The flavor is characteristic, and to some palates suggests a combination of a pleasant mild acid with caramel or brown sugar. The sapodilla is a not uncommon commercial fruit in large fruit shops.

Perhaps no fruit of the Tropics is more often discussed than the mango, some persons being exceedingly fond of this juicy aromatic fruit while others are as outspoken in their dislike. There are countless varieties of the mango, and many of them have a rank turpentine-like flavor, and are very fibrous. These qualities are not apparent, however, in the best varieties, which are of very delicate flavor and very palatable. The fruit is cooked in a variety of ways, being a staple article of diet in the Tropics, and is also eaten fresh. Some difficulty is experienced in shipping mangoes, as the flesh is very juicy and tender, but they are occasionally found in market at least as far north as Washington, D. C.

TABLE 1.—*Average composition of fruits and fruit products.*

Kind of fruit.	Refuse.	Edible portion.						
		Water.	Protein.	Ether extract.	Carbohydrates.		Ash.	Fuel value per pound.
					Nitrogen-free extract.	Crude fiber.		
FRESH FRUITS.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Calories.*
Apples	25.0	84.6	0.4	0.5	13.0	1.2	0.3	290
Apricots	6.0	85.0	1.1	.....	13.4		.5	270
Avocado	29.0	81.1	1.0	10.2	6.8		.9	512
Bananas	35.0	75.3	1.3	.6	21.0	1.0	.8	460
Blackberries	.....	86.3	1.3	1.0	8.4	2.5	.5	270
Cactus fruit	.....	79.2	1.4	1.3	11.7	3.7	2.7	375
Cherries	5.0	80.9	1.0	.8	16.5	.2	.6	365
Cranberries	.....	88.9	.4	.6	8.4	1.5	.2	215
Currants	.....	85.0	1.5	.....	12.8		.7	265
Currants (black) [a]	.....	79.0	[b] 5	[b] 3	13.1	[a] 6.1	1.0	370
Figs	.....	79.1	1.5	.....	18.8		.6	380
Gooseberries [a]	.....	85.6	[b] 1.0	.....	[c] 13.1		.3	255
Grapes	25.0	77.4	1.3	1.6	14.9	4.3	.5	450
Guava [a]	.....	82.9	1.3	.7	8.0	6.6	.5	315
Huckleberries	.....	81.9	.6	.6	16.6		.3	345
Lemons	30.0	89.3	1.0	.7	7.4	1.1	.5	205
Loquat	.....	77.9	.2	.....	20.2	.6	1.1	395
Mango [a]	[b] 40.0	87.4	.6	.4	9.9	1.2	.5	220
Medlar [a]	.....	74.6	.5	.3	16.5	7.5	.6	455
Mulberry [a]	.....	84.7	.4	.....	14.3		.6	280
Muskmelons	50.0	89.5	.6	.....	7.2	2.1	.6	185
Nectarines	6.6	82.9	.6	.....	15.9		.6	305
Olives	17.9	67.0	2.5	17.1	5.7	3.3	4.4	497
Oranges	27.0	86.9	.8	.2	11.6		.5	240
Peaches	18.0	89.4	.7	.1	5.8	3.6	.4	190
Pears	10.0	80.9	1.0	.5	15.7	1.5	.4	163
Persimmons	[b] 25.0	66.1	.8	.7	29.7	1.8	.9	630
Persimmons (Japanese)	24.0	80.2	1.4	.6	15.1	2.1	.6	174
Pineapples	40.0	89.3	.4	.3	9.3	.4	.3	200
Plums	5.0	78.4	1.0	.....	20.1		.5	395
Pomegranates	[b] 30.0	76.8	1.5	1.6	16.8	2.7	.6	460
Prunes	5.8	79.6	.9	.....	18.9		.6	370
Raspberries (red)	.....	85.8	1.0	.....	9.7	2.9	.6	255
Raspberries (black)	.....	84.1	1.7	1.0	12.6		.6	310
Red bilberry	.....	89.6	.1	[b] 3	3.8	[b] 6.0	.2	190
Rhubarb stalks	40.0	94.4	.6	.7	2.5	1.1	.7	105
Roselle calyx	.....	86.5	2.1	.3	10.3		.8	235
Roselle pod	.....	84.0	1.7	1.0	12.2		1.1	290
Sapodilla [a]	[b] 40.0	77.9	.5	1.6	16.6	2.8	.6	425
Scarlet haws	20.0	75.8	2.0	.7	18.6	2.1	.8	212
Strawberries	5.0	90.4	1.0	.6	6.0	1.4	.6	180
Surinam cherry	.....	85.0	.4	.....	13.9		.7	260
Watermelons	59.4	92.4	.4	.2	6.7		.3	140
Whortleberries	.....	82.4	.7	3.0	10.3	3.2	.4	390
DRIED FRUITS.								
Apples	.....	26.1	1.6	2.2	62.0	6.1	2.0	1,350
Apricots	.....	29.4	4.7	1.0	62.5		2.4	1,290
Bananas [a]	.....	29.2	5.3	2.3	55.8	2.1	5.3	1,240
Banana flour	.....	9.7	3.1	.5	83.4	.7	2.6	1,610
Citrons	.....	19.0	.5	1.5	78.1		.9	1,525
Dates	10.0	15.4	2.1	2.8	74.6	3.8	1.3	1,615
Figs	.....	18.8	4.3	.3	68.0	6.2	2.4	1,475
Pears	.....	16.5	2.8	5.4	66.0	6.9	2.4	1,635
Prunes	15.0	22.3	2.1	.....	71.2	2.1	2.3	1,400
Raisins	10.0	14.6	2.6	3.3	73.6	2.5	3.4	1,605
Raspberries	.....	8.1	7.3	1.8	80.2		2.6	1,705
St. John's bread	.....	[b] 17.3	5.7	1.1	67.0	6.4	2.5	1,480
Zante currants (English currants)	.....	17.2	2.4	1.7	71.2	3.0	4.5	1,495
CANNED FRUITS, PRESERVES, JELLIES, ETC.								
Crab apples (canned)	.....	42.4	.3	2.4	54.4		.5	1,120
Apple sauce	.....	61.1	.2	.8	37.2		.7	730
Apricots (canned)	.....	81.4	.9	.....	17.3		.4	340
Apricot sauce	.....	45.2	1.9	1.3	48.8		2.8	1,000
Blackberries (canned)	.....	40.0	.8	2.1	56.4		.7	1,150
Blueberries (canned)	.....	85.6	.6	.6	12.8		.4	275
Cherries (canned)	.....	77.2	1.1	.1	21.1		.5	415
Cherry jelly	.....	21.0	1.1	.....	77.2		.7	1,455

[a] European analysis. [b] Assumed. [c] Including 3.5 per cent skin and seeds.

TABLE 1.—*Average composition of fruits and fruit products*—Continued.

Kind of fruit.	Refuse.	Edible portion.						
		Water.	Protein.	Ether extract.	Carbohydrates.		Ash.	Fuel value per pound.
					Nitrogen-free extract.	Crude fiber.		
CANNED FRUITS, PRESERVES, JELLIES, ETC.—continued.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Calories.*
Figs, stewed		56.5	1.2	0.3	40.9		1.1	785
Grape butter		36.7	1.2	.1	58.5		3.5	1,115
Olives, green, pickled	27.0	58.0	1.1	27.6	11.6		1.7	1,400
Olives, ripe, pickled	19.0	64.7	1.7	25.9	4.3		3.4	1,205
Orange marmalade		14.5	.6	.1	84.5		.3	1,585
Peaches (canned		88.1	.7	.1	10.8		.3	220
Pears (canned)		81.1	.3	.3	18.0		.3	355
Pineapples (canned)		61.8	.4	.7	36.4		.7	715
Prunes, stewed		76.6	.5	.1	22.3		.5	430
Strawberries, stewed		74.8	.7		24.0		.5	460
Angelica stalks (candied)		10.4	.1	.1	87.3	1.5	.6	1,550
Apricots (candied)		14.4	.7	.1	83.0	1.1	.7	1,445
Cherries (candied)		12.1	.5	.2	86.1	.5	.6	1,455
Citron (candied)		18.2	.1	.1	77.6	1.0	3.0	1,380
Ginger root (candied)		12.3	.3	.2	86.1	.7	.4	1,520
FRUIT PRODUCTS.								
Olive oil				100.0				4,035
Raspberry juice		48.3	.5		[a] 49.9		.3	935
Unfermented grape juice		92.2	.2	[b] .5	6.9		.2	150
OTHER FOODS FOR COMPARISON.								
Cabbage	15.0	91.5	1.3	.3	4.5	1.1	1.0	145
Potatoes	20.0	78.3	2.2	.1	18.0	.4	1.0	385
Wheat flour, high grade		12.3	11.4	1.0	74.8	.3	.5	1,650
Corn meal, bolted		12.5	9.2	1.9	74.4	1.0	1.0	1,655
White bread		35.3	9.2	1.3	52.6	.5	.5	1,215
Beans, dried		12.6	22.5	1.8	55.2	4.4	3.5	1,605
Honey		18.2	.4		81.2		.2	1,520
Sugar, granulated					100.0			1,860
Butter		11.0	1.0	85.0			3.0	3,605

[a] Probably contained added sugar. [b] European analysis.

Most fruits, like other classes of foods, contain more or less material, such as pits, skin, etc., which is inedible. When such portions are removed a larger or smaller part of the edible material is almost always of necessity removed also, and is spoken of as "waste." In reporting analyses the amounts of inedible material and waste are grouped together under the heading "refuse." As may be seen from the above table, the proportion of refuse in fruits varies within rather wide limits. Thus, of pears it constitutes on an average 10 per cent of the total fruit, peaches 18 per cent, apples and grapes 25 per cent, and bananas 35 per cent, while in the case of raspberries and blackberries there is no refuse and the whole fruit can be eaten. The composition of some fresh and dried fruits is shown graphically in figure 1.

The analytical data quoted above show that fresh fruits are in general dilute foods—that is, the proportion of water which they contain is large, compared with the total amount of nutritive material. It has been suggested that fruits containing 80 per cent or more of water be classed as flavor fruits and those with less than 80 per cent as food

fruits. As may be seen from the table (p. 14), such fruits as strawberries, blackberries, and raspberries would be included in the first class, and fresh figs, bananas, grapes, etc., in the second. In dried fruits which have been concentrated by evaporation the percentage

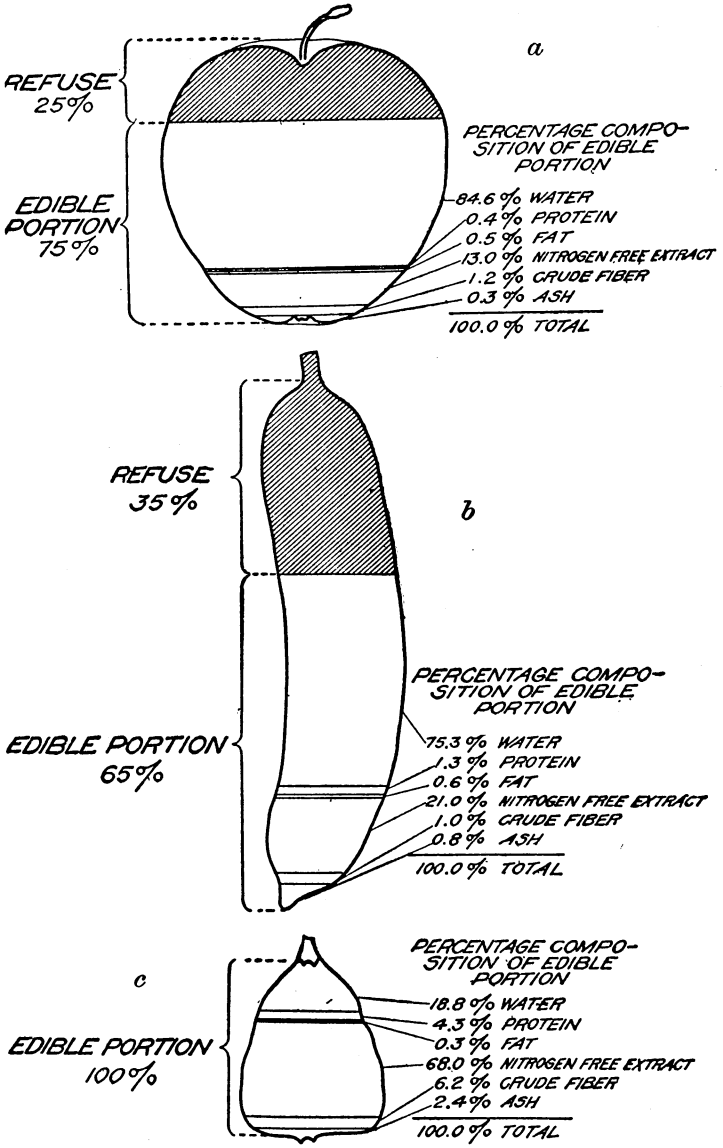

FIG. 1.—Composition of apple (*a*), banana (*b*), and dried fig (*c*).

of nutrients is very much higher than in fresh fruits. Some preserved fruits also possess a comparatively high nutritive value, owing to the evaporation of water by the heat of cooking or to the addition of

sugar, or to both factors. Candied fruits, such as cherries and apricots, which are included in the table, may be looked upon as typical examples of this class of fruit products. As regards composition, the water content is low and the carbohydrates and consequently the energy value is very high, owing to the added sugar.

Olives and the avocado are remarkable for the large percentage of fat which they contain, but in general it may be said that this constituent is present in very small proportion in fresh fruits. In the case of the apple, pear, etc., it seems probable that the small amount of fat obtained in chemical analysis consists of the coloring matter contained in the fruit or of wax found in the skin. That the amount of wax may be considerable is evident when we recall the fact that fruit wax is collected from bay berries and other fruits in quantities sufficient for candle making and other purposes. That common fruits actually contain fat, though it is not generally associated with them, is shown by a recently published study of the fat of woods strawberries. The dried berries when extracted yielded a small amount of oil, cloudy at ordinary temperatures, but clear when heated, and much like linseed oil in its properties.

In the majority of fruits and fruit products the carbohydrates are the food constituents most abundantly represented. The figures in the table show that the proportion of nitrogen-free extract varies greatly, being lowest in the fresh and highest in the dried and preserved fruits. It is interesting to consider also the values which have been reported for some of the constituents not shown in the table, but included in the group "nitrogen-free extract." In seeds which are commonly eaten, such as the cereal grains, and beans, peas, and other legumes, the nitrogen-free extract is quite largely made up of starches. In fruits, however, sugars and the so-called pectin bodies, with very often more or less starch, make up the group. The principal sugars in fruit are cane sugar, grape sugar (glucose), and fruit sugar (levulose), the last two being usually present together in equal quantity and designated invert sugar or reducing sugar. The stage of growth and the degree of ripeness have a very marked effect on the kind and amount of sugar, and it is therefore difficult to give average figures for the quantities present which will be fairly representative. An idea of the range in the sugar content of ripe fruits may be gathered from figures quoted from a summary[a] published several years ago. According to these data, invert sugar ranged from 2 per cent in round numbers in large early apricots to 15 per cent in grapes and a variety of sweet cherries. A number of fruits (strawberries, gooseberries, raspberries, and apples) contained

[a] Lippman: Chemie der Zuckerarten, 1895, 3d ed., pp. 493, 591; 1904, 4th ed., pp. 200, 794.

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about half the latter quantity. The cane sugar ranged from less than 1 per cent in lemons to 14 per cent in a variety of plums. Bananas also contained a fairly high percentage, namely, 11 per cent.

Fruit sugar rarely occurs unaccompanied by grape sugar, but has been thus reported in the mango and in amounts large in proportion to the grape sugar in sweet apples and sweet pears and a number of varieties of grapes. In the case of grape sugar large amounts—18 to 30 per cent—have been reported in juice of different sorts of grapes, while in dried fruits the values are even higher, 32 per cent having been found in prunes, 54 per cent in Zante or "English" currants, which are of course a small seedless grape, 61 per cent in raisins, 48 per cent in figs, and 66 per cent in dates.

The acid in fruits, which in proximate analyses is not usually determined separately, varies within rather wide limits, 1 to 2 per cent being reported on an average in such fruits as apples, pears, plums, strawberries, etc., and as high as 7 per cent or more in lemon juice. It often happens that of two fruits with the same acid content one has a much sourer taste than the other, because the acid is not so much masked by sugar.

Fruits contain a comparatively small amount of mineral matter—less than 1 per cent on an average—consisting quite largely of potassium salts, with a little phosphoric acid, iron, lime, etc.

As a class, it is apparent that fresh fruits are directly comparable with green vegetables and root crops rather than with more concentrated foods, such as flour or meal. The dried and some of the preserved fruits, which are more concentrated than the fresh, compare favorably with bread, dried beans, and similar foods on the basis of total food material present. There is this difference, however, that the cereals and dried legumes contain fairly large proportions of protein, while the quantity present in fruits is always small. In other words, fruits—fresh, dried, and preserved—are sources of energy rather than of tissue-forming material.

Grape juice and other freshly expressed juices are pleasant and wholesome beverages. They are commonly preserved for winter use at home as well as on a commercial scale by sterilizing in bottles. The fruit juices are dilute foods, as the figures given for grape juice in Table 1 indicate. Fruit sirups made by adding sugar to the juice are extensively used in the household and in other ways. The food value of such articles is, of course, considerably increased by the sugar which they contain.

In connection with the subject of fruit juices and sirups, it may be of interest to mention the Turkish preparation, which is made by evaporating grape juice until it is of the consistency of molasses, then thickening with flour or starch, and spreading it out to dry in the sun

in thin sheets. This product is not unlike the peach leather, which is an old-fashioned domestic product still made to some extent in much the same way in the southern United States by drying crushed peach pulp on platters in an oven. Plum leather is also sometimes made in the same way. After soaking in water for some hours peach leather is ready for use on the table or for making puddings, etc. Another Turkish preparation called sujuk or rojik is made by stringing walnuts on pieces of stout twine about a yard long and immersing them in a mixture of grape molasses and flour. After receiving a coating about one-fourth of an inch thick they are withdrawn and hung up to dry, and may then be preserved in jars in good condition for a few months. Sujuk is said to be an excellent article of food and palatable. Sometimes wheat grits are used to thicken the grape sirup, and the nut and sirup mixture is made in the form of cakes about one-half an inch thick when dried.

Vinegar which contains about 3 per cent of extractive material and 0.5 per cent ash, in addition to 6 per cent acetic acid and over 90 per cent water, is one of the oldest fruit products and also one of the oldest and most common condiments and household preservatives. It owes its use in the diet to flavor and other qualities rather than to the very small amount of nutritive material which it may contain. Honey vinegar,[a] malt vinegar, etc., are well known, but vinegar made from fruit juice is far more common. By fermentation the sugar in the original material is converted into acetic acid, and to this the vinegar largely owes its flavor, though the salts and other materials originally present in the fruit juice have an effect upon this quality. Vinegar made from apple juice—that, is cider vinegar[b]—has always had a reputation for good quality, though other fruit juices are of considerable importance in domestic vinegar making, banana vinegar being one of the sorts which is rather favorably known in regions where this fruit is grown. The acid juice of lemons and limes is used like vinegar as a condiment, and many persons consider that lemon juice is more delicate. It is sometimes claimed that it is more wholesome also, but this seems hardly more than a matter of opinion, as there is no reason to suppose that the small amounts of vinegar ordinarily used are in any way harmful.

Verjuice, the expressed acid juice of green apples, crab apples, or other unripe fruit, was formerly used as a condiment and was greatly prized. It has survived in modern cookery in a limited way and may occasionally serve a useful purpose when lemon juice is not readily obtainable.

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[a] For description and method of making, see U. S. Dept. Agr., Farmers' Bul. 276.

[b] Vinegar making and related questions are taken up in U. S. Dept. Agr., Farmers' Bul. 233.

RIPENING AND ITS EFFECT ON COMPOSITION.

As fruits grow to their full size and ripen they undergo marked changes in chemical composition with respect both to the total and to the relative amount of the different chemical bodies present. When stored after gathering, the changes continue, some fruits improving on storage and others deteriorating very rapidly. In general, ripe fruits are less acid than green and contain less starch, woody material, crude fiber, and the carbohydrates commonly referred to as pectin bodies (see p. 29), and correspondingly larger amounts of the different sugars.

Fruits contain oxydases and other ferments, and these are believed to play a very important part in the chemical changes which accompany growth and maturity. Many diverse views have been expressed regarding the exact nature and extent of the processes involved and the compounds formed in ripening fruit. The question as a whole has been a favorite one with chemists, and the agricultural experiment stations have made a number of important contributions to the subject. One of the most recent and valuable contributions, both from a bibliographical and from a chemical standpoint, is the series of investigations published by Bigelow [a] and his associates, of the Bureau of Chemistry of the Department of Agriculture, on the ripening of winter and summer apples and of peaches. With winter apples it was found that the starch increases from early summer until the maximum is reached in midsummer and then decreases and finally disappears. The malic acid content decreases from early summer until maturity, while cane sugar and invert sugar increases.

In the case of peaches, as the fruit develops from early summer to ripeness the proportion of flesh increases and the pit decreases. During this period the weight of reducing sugars increases about eight times and that of cane sugar or sucrose and acids considerably more than this. An increase is also noted with the various forms of nitrogenous substances. Throughout the whole period of growth the proportion of solids to water in the flesh of the peach remains fairly constant. The pit, on the other hand, becomes harder and the percentage of water in it decreases as growth progresses. It is interesting to note that throughout the whole period of growth no appreciable amount of starch is found in the peach. Between the condition known as market ripeness and full ripeness considerable growth takes place in the peach, there being an increase in both water and solid matter and in reducing sugar and cane sugar. A German investigator [b] found that when black currants were picked when slightly green and kept for a few days there was an increase

[a] U. S. Dept. Agr., Bureau of Chemistry Buls. 94 and 97.

[b] Landw. Jahrb. Schweiz., 19 (1905), p. 600.

in sugar and a decrease in the acid content. The changes which take place in gooseberries do not appear to be of the same character. Picked when green, they contain 3.9 per cent sugar and 27.2 per cent acid. When stored at a cool temperature for six days they had taken on the dark color of ripe berries and contained somewhat smaller proportions of both sugar and acid.

A knowledge of the changes which accompany the growth, ripening, and storage of fruits is very important commercially as well as from the housekeeper's standpoint. For instance, in cider making it is desirable that the fruit should be used when the sugar content is high, as the quality of cider and vinegar is largely determined by the amount of sugar present. As every housewife knows, underripe fruit—that is, fruit which still contains the so-called pectin bodies rather than the sugars and other carbohydrates characteristic of fully ripened fruit—is the most satisfactory for jelly making. (See p. 29.) In the case of bananas the underripe fruit, rich in starch, is best for cooking, and the very ripe fruit, in which the starch has been changed into sugar, for use uncooked. It is not unlikely that failure to recognize this distinction is responsible for the digestive disturbance which many persons experience when bananas are eaten, as the raw, underripe, starchy fruits are generally conceded to be difficult of digestion. The underripe bananas, when dried, sliced, and ground, yield a flour or meal rich in starch, while the riper fruit with the higher sugar content, sliced and dried, is very sweet and not unlike figs in flavor and composition.

WAYS OF SERVING FRUIT.

As regards the way in which they are served fruits range from the muskmelon, watermelon, and avocado, almost never cooked, to cranberries and the ordinary varieties of quince, which are not eaten raw. The methods of preparation are quite varied, including drying or evaporating, and baking, boiling, and stewing, while quantities of fruit are used in puddings, pies, and other dishes, and for the preparation of jams, jellies, and preserves. Fruit juices are used for beverages, and both fruits and the juices are very commonly prepared for the table by freezing, fruit ices being considered as among the most appetizing desserts. Some fruits, notably the green and the ripe olive and less generally the lime, are prepared for the table by pickling in brine.

Even a casual examination of cookery books and the periodical literature devoted to such topics shows that the ways in which fruits and fruit products can be cooked and served are practically endless. The housewife who desires to vary her menu by the use of more fruit and fruit dishes can do so very readily by consulting such sources of information.

The temperature at which fresh fruits are eaten is largely a matter of fashion or individual taste. With the increased use of ice in our homes during recent years it has become a very common custom to serve fruits colder than was formerly the case. Cool or even cold fruits are very refreshing and many prefer them served thus. There are others, however, who maintain that overchilling lessens the delicate flavor and accentuates the acid taste. They insist that the fruits gathered in the cool of the day and stored in a cool but not a cold place are at their best. Still others find them sweetest and most palatable when brought from the garden warmed by the sun.

PLACE OF FRUIT IN THE DIET.

In most families fruits are commonly thought of as a food accessory, and are prized for their pleasant flavor or for supposed hygienic reasons rather than for their food value; yet a study of available figures shows that they constitute a by no means unimportant part of the diet, since they supply, on the basis of recent statistics, 4.4 per cent of the total food and 3.7 per cent of the total carbohydrates of the average American diet (see also p. 36). With a view to learning something more definite regarding the possibilities of fruits as sources of nutrients, the relative cost of nutrients supplied by fruits and other foods, the digestibility of a fruit diet as compared with an ordinary mixed diet, and related questions, extended investigations were undertaken at the California Agricultural Experiment Station by Prof. M. E. Jaffa, the work as a whole being carried on in cooperation with the nutrition investigations of the Office of Experiment Stations. In the first series reported six dietary studies were made with fruitarians—two women and four children who had lived on a fruit and nut diet for several years. The dietary studies covered from twenty to twenty-eight days, and the daily food consisted of different combinations of fruits and nuts, of which the following day's ration may serve as a sample: 475 grams apples, 110 grams bananas, 850 grams oranges, 5 grams dates, 2 grams honey, 10 grams olive oil, 55 grams almonds, 70 grams pine nuts, and 50 grams walnuts.

The later studies were made with one of the women and two of the children included in the first group, and in addition with two elderly men who had been vegetarians for years and had limited their diet almost exclusively to fruits and nuts, and with two young men, university students, who were accustomed to the ordinary diet, though one of them had experimented with a vegetarian and fruitarian diet for some time. The students and one of the elderly men ate three meals a day at the usual hours. The others ate but twice, the first meal being taken between 10 and 11 o'clock in the morning and the

second between 5 and 6 o'clock in the afternoon. As before, the diet included a large assortment of fresh fruits, with considerable quantities of dried fruits and nuts, and some honey and olive oil. In a few cases small quantities of other foods were also eaten.

Considering these studies as a whole, the diet of the women and children furnished from 32 to 43 grams of protein and 1,190 to 1,430 calories of energy per day, the cost ranging from 15.7 to 27.5 cents. It is the usual custom to discuss dietary studies on the basis of the amounts eaten per man per day, and the results obtained with these women and children, when recalculated to this basis, showed a range of 47 to 80 grams of protein and 1,850 to 2,805 calories of energy, the cost of the daily food ranging from 21 to 55 cents per man per day. In the studies with the young and the old men the protein supplied by the daily diet ranged from 40 to 85 grams and the energy from 1,712 to 3,305 calories, the average being 62 grams protein and 2,493 calories, the cost ranging from 18.1 to 47 cents per person per day. These amounts are considerably smaller than have been found on an average with families living in many different regions of the United States and under a variety of conditions, as is shown by the fact that with 52 families in comfortable circumstances the average protein in the daily diet was 103 grams and the average energy 3,500 calories. On the other hand, in many of the dietary studies made under the auspices of the Office of Experiment Stations it has been found that persons living on a mixed diet have obtained amounts directly comparable with those supplied by the fruitarian diet. Thus, at the North Dakota Agricultural College several years ago a dietary study showed that the food consumed per man per day by a group of students furnished 64 grams protein and 2,579 calories and at Lake Erie College 68 grams protein and 2,610 calories, calculated on a uniform basis per man per day.

In a recent investigation carried on at Harvard it was found that the diet of nine students who lived at the college commons and, from necessity or choice, endeavored to live cheaply supplied, on an average, 89 grams protein and 3,068 calories. In this case the average cost was 39.9 cents per day and at the North Dakota and the Lake Erie colleges 13 and 18 cents, respectively. It will thus be seen that in the California investigations the fruit and nut diet supplied the subjects with amounts of protein and energy which are directly comparable with those obtained by many other persons from a mixed diet, though in general the quantities were smaller than are supplied by the diet of the average family. It should be said that the persons living on a fruit and nut diet apparently maintained their normal health and strength, and it is only fair to conclude that if, for any

reason, such a course seems desirable it is perfectly possible to select a diet made up of fruits and nuts which, for long periods at any rate, will supply the body with the requisite protein and energy, as was shown by a detailed study of the results of the California experiments. In such a diet nuts were the principal sources of protein and nuts, olives, or the expressed olive oil the chief source of fat, while fruits, fresh and dried, supplied the bulk of the carbohydrates.

As regards cost, it will be seen that there was a considerable range with the fruitarian diet, the amount expended per person per day being in some cases quite low and in others quite high. On the whole, the range did not differ greatly from that observed in many instances on an ordinary mixed diet.

It would seem from the recorded data that it is more difficult for the subjects to obtain the requisite amount of protein when on a limited diet of one kind of nut combined with fruits than it is when they are unrestricted and eat a variety of both fruits and nuts. In nearly all cases where the diet was limited to combinations of one or two fruits with one kind of nuts the subjects complained of a constant craving for some other food, such as green vegetables or cereals, and in these cases it was found that the coefficients of digestibility were lower than in those tests in which some vegetable or cereal was eaten, which made the diet more appetizing. The addition of a small amount of some cereal food to the diet markedly increased its protein and energy value.

It would be going too far to conclude on the basis of the California investigations that a fruitarian diet in general is equal or superior to the ordinary diet, and indeed the study of this question was not a part of the investigation. Before such a conclusion could be drawn it would be necessary to make investigations extending over a long period of years and with a variety of subjects, and which would take into account resistance to disease and other unfavorable conditions, body development, the health and condition of the offspring of persons living for years on such a diet, and other similar questions. It seems fair to say, however, that at the present time the consensus of opinion of well-informed physiologists is that the ordinary mixed diet is most convenient and satisfactory for the average individual. It is equally clear from the investigations reported that fruits and nuts should not be looked upon simply as food accessories, but should be considered a fairly economical source of nutritive material. It must be remembered, too, that the use of fruits, fresh and preserved, often makes palatable an otherwise rather tasteless meal. Jam with our bread is a reasonable combination, the highly flavored fruit product whetting the appetite for the needed quantity of rather flavorless bread.

DIGESTIBILITY OF FRUIT.

In addition to the dietary studies, a large number of digestion experiments were made at the California Experiment Station for the purpose of learning how thoroughly a diet made up of various combinations of fruits and nuts was assimilated. In such an experiment covering 10 days, made with a child 7 years old, on an average 82 per cent of the protein, 87 per cent of the fat, 96 per cent of the nitrogen-free extract (sugar, starches, etc.), 80 per cent of the crude fiber, and 54 per cent of the ash of the food eaten were digested, and 87 per cent of the energy of the diet was available to the body. In 30 experiments with men, 75 per cent of the protein, 86 per cent of the fat, 95 per cent of the nitrogen-free extract, 79 per cent of the crude fiber, and 55 per cent of the ash of the fruit and nut diet were digested, and 86 per cent of the energy was available. These values are comparable with those obtained from an ordinary mixed diet, as is shown by the fact that in 93 experiments with young men 93 per cent of the protein, 95 per cent of the fat, and 98 per cent of the total carbohydrates supplied were assimilated. The average coefficients of digestibility which have been calculated for fruits in connection with the nutrition investigations carried on under the auspices of the Office of Experiment Stations are protein 85 per cent, fat 90 per cent, and carbohydrates 90 per cent, and those for fresh vegetables, protein 83 per cent, fat 90 per cent, and carbohydrates 95 per cent.

The feces excreted per person per day on the fruit and nut diet in the California experiments were less in amount than has been the case in some experiments with a mixed diet or a ration of bread and milk. This is contrary to what has been commonly found with a vegetarian diet made up of bread and other cereal foods, garden vegetables, etc., and containing little if any fruit or nuts. The percentage of so-called metabolic nitrogen in the feces from the fruit and nut diet did not exceed that reported by other investigators in tests with a bread and milk diet. In other words, if the amount of metabolic products can be looked upon as a measure of the work of digestion, no more effort is required to digest the fruit and nuts than is needed for bread and milk. Although, as Professor Jaffa points out, it is undoubtedly advisable to wait until more data have been obtained before making definite statements regarding the digestibility of fruits and nuts, enough has been done to show that they are almost completely digested and have a higher nutritive value than is popularly attributed to them. In view of this it is certainly an error to regard fruit as something of value only for its pleasant flavor or for its hygienic or medicinal properties, or to consider nuts simply as an accessory to an already hearty meal. As shown by the composition and digestibility of both fruit

and nuts, they can be favorably compared with other and more common food.

So far as can be learned, comparatively few investigations have been made to ascertain the digestibility of particular fruits, raw or cooked. In a series of investigations by Bryant and Milner the digestibility of apple sauce was determined when eaten with a simple basal ration. The coefficients of digestibility for apple sauce alone were calculated in the usual way and were, protein 28 per cent, nitrogen-free extract 99.6 per cent, crude fiber 96 per cent, and ash 100 per cent, while all the energy supplied by the apple sauce was considered to be available to the body. The coefficient of digestibility of protein is low, but, as the authors pointed out, the total amount of this constituent present was so small that it may be disregarded. This investigation, like those at the California Experiment Station, indicates that the fruit carbohydrates (sugar, starches, etc.), that is, the principal nutritive materials which fruits supply, are very thoroughly assimilated.

Few studies seem to have been made to determine the ease or rapidity of digestion of different fruits in the stomach, but a comparison of available data indicates that fruits compare favorably with other common foods as regards stomach digestion. Apparently it is fair to say that stomach digestion is influenced by the nature of the fruit and its stage of ripeness. Beaumont states that mellow sour apples eaten uncooked require 2 hours for digestion in the stomach and mellow sweet apples 1.5 hours. Another observer notes that about 5 ounces of raw ripe apple requires 3 hours and 10 minutes for digestion in the stomach, but states that if the fruit is unripe, and consequently contains a high proportion of cellulose, a much longer time may be required.

Little is definitely known regarding the relative digestion and absorption of fruits in the intestine, but experiments indicate that as a class ripe fruits are quite thoroughly digested, and it is evident that, generally speaking, fruits, like other foods, usually remain in the intestinal tract long enough for the body to absorb the nutritive material present, and that therefore the rate of intestinal digestion would not be a matter of special importance.

RELATIVE ECONOMY OF FRUITS AND OTHER FOODS.

In connection with his studies of the comparative value of fruits, Professor Jaffa summarizes data regarding the cost of nutrients and energy supplied by fruits as compared with some other foods at certain values per pound. Some of his data follow.

TABLE 2.—*Comparative cost of total nutrients and energy in fruits and other food materials at certain average prices.*

Kind of food material.	Price per pound.	Cost of 1 pound protein.	Cost of 1,000 calories energy.	Amounts for 10 cents.				
				Total weight of food materials.	Protein.	Fat.	Carbohydrates.	Energy.
FRESH FRUITS.	*Cents.*	*Dolls.*	*Cents.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Calories.*
Apples	1.5	5.00	7.3	6.67	0.02	0.02	0.72	1,467
Bananas	7.0	8.75	23.3	1.43	.01	.....	.21	429
Grapes	4.0	4.00	11.9	2.50	.03	.03	.36	837
Oranges	6.0	10.00	35.2	1.67	.01	.....	.14	284
Peaches	4.0	8.00	25.1	2.50	.01	.....	.19	398
Pears	3.0	6.00	11.5	3.33	.02	.01	.42	866
Plums	3.0	3.33	8.1	3.33	.03	.....	.64	1,232
Watermelons	1.5	7.50	25.0	6.67	.01	.....	.18	400
Blackberries	7.0	5.38	25.9	1.43	.02	.01	.16	336
Cranberries	5.0	12.50	23.3	2.00	.01	.01	.20	430
Currants	5.0	3.33	18.9	2.00	.03	.....	.26	530
Raspberries	7.0	7.00	27.4	1.43	.01	.....	.18	365
Strawberries	7.0	7.78	40.0	1.43	.01	.01	.10	250
DRIED FRUITS.								
Apples	12.0	7.50	8.9	.83	.01	.02	.55	1,121
Dates	10.0	5.26	6.9	1.00	.02	.03	.71	1,450
Figs	15.0	3.50	10.2	.67	.03	.....	.50	968
Prunes	10.0	5.56	8.4	1.00	.02	.....	.62	1,190
Raisins	10.0	4.35	6.9	1.00	.02	.03	.69	1,445
JAMS, PRESERVES, ETC.								
Apple preserves	16.0	91.43	13.8	.62	.....	.....	.39	727
Apple butter	5.0	10.00	5.6	2.00	.01	.....	.94	1,780
Currant and raspberry jam	16.0	26.66	12.8	.62	.....	.....	.42	781
Gooseberry jam	16.0	32.00	13.2	.62	.....	.....	.40	752
Orange marmalade	16.0	26.66	10.1	.62	.....	.....	.52	983
Prune sauce	16.0	32.00	37.2	.62	.....	.....	.14	267
Strawberry preserves	16.0	26.67	12.0	.62	.....	.....	.44	833
Apple jelly	16.0	53.33	12.2	.62	.....	.....	.43	812
Currant jelly	16.0	40.00	13.4	.62	.....	.....	.40	744
Guava jelly	16.0	53.33	10.5	.62	.....	.....	.51	952
Quince jelly	16.0	80.00	13.3	.62	.....	.....	.40	750
Apricots, canned	16.0	17.78	47.1	.62	.01	.....	.11	211
Pears, canned	16.0	53.33	45.5	.62	.....	.....	.11	220
Peaches, canned	16.0	20.00	53.2	.62	.....	.....	.09	188
Grape juice	20.0	83.33	128.2	.50	.....	.....	.04	78
OTHER FOODS FOR COMPARISON.								
Porterhouse steak	25.0	1.31	22.5	.40	.07	.07	.....	444
Leg mutton, hind	20.0	1.30	22.2	.50	.07	.07	.....	445
Whole milk	3.5	1.06	10.5	2.86	.09	.11	.14	925
Skim milk	2.0	.59	11.8	5.00	.17	.02	.26	850
Wheat flour, patent roller process, high grade and medium	2.5	.22	1.5	4.00	.46	.04	3.00	6,600
White bread	5.0	.54	4.2	2.00	.18	.03	1.06	2,430
Rye bread	5.0	.56	4.3	2.00	.18	.01	1.06	2,360
Sugar	6.0	.....	3.2	1.67	.....	.....	1.67	3,106
Candy	20.0	.....	11.2	.50	.....	.....	.48	892
Beans, dried	5.0	.22	3.1	2.00	.45	.03	1.19	3,210
Celery	5.0	5.56	71.4	2.00	.02	.....	.05	140
Potatoes, 90 cents per bushel	1.5	.83	4.8	6.67	.12	.01	.98	2,068

From the data in the foregoing table it appears that fruits are comparatively expensive sources of protein as compared with flour or dried legumes, the fruit juices being the most expensive and the dried fruits the cheapest of the fruit products. Ten cents on an average will purchase fully as much energy when spent for fresh fruits and more when spent for dried fruits than for lean meats, but much less than when expended for wheat flour. From the data as a whole it is apparent that fruits are reasonably cheap sources of energy in the

diet and are well suited on grounds of economy for combination in reasonable quantity with cheap proteid foods to furnish a well-balanced ration.

COOKING AND ITS EFFECTS ON FRUIT: JELLY MAKING.

As is the case with all vegetable foods, the heat of cooking breaks down the carbohydrate walls of the cells which make up the fruit flesh, either because the moisture or other cell contents expands and ruptures the walls or because the cell wall is itself softened or dissolved. Texture, appearance, and flavor of fruit are materially modified by cooking, and if thorough it insures sterilization, as in the case of all other foods. The change in texture often has a practical advantage, since it implies the softening of the fruit flesh so that it is more palatable and may be more readily acted upon by the digestive juices. This is obviously of more importance with the fruits like the quince, which is so hard that it is unpalatable raw, than it is with soft fruits like strawberries. When fruits are cooked without the addition of water or other material, as is often the case in baking apples, there is a loss of weight, owing to the evaporation of water, and the juice as it runs out carries some carbohydrates and other soluble constituents with it, but under ordinary household conditions this does not imply waste, as the juice which cooks out from fruit is usually eaten as well as the pulp. Cooking in water extracts some of the nutritive material present. Thus, a German investigator found that after boiling, apples and pears contained 4 or 5 per cent and peaches about 7 per cent less carbohydrates than the uncooked fruit. In this case also such removal of nutritive material is of no practical importance.

The idea is quite generally held that cooking fruit changes its acid content, acid being sometimes increased and sometimes decreased by the cooking process. Kelhofer [a] showed that when gooseberries were cooked with sugar the acid content was not materially changed, these results being in accord with his conclusions reached in earlier studies with other fruits. The sweeter taste of the cooked product he believed to be simply due to the fact that sugar masks the flavor of the acid.

It is often noted that cooked fruits, such as plums, seem much sourer than the raw fruit, and it has been suggested that either the acid was increased or the sugar was decreased by the cooking process. This problem was studied by Sutherst,[b] and in his opinion the increased acid flavor is due to the fact that cooked fruit (gooseberries, currants, plums, etc.) usually contains the skin, which is commonly rejected if the fruit is eaten raw. The skin is more acid than the

[a] Landw. Jahrb. Schweiz., 19 (1905), pp. 601, 602.

[b] Chem. News, 92 (1905), No. 2393, p. 163.

pulp, as was shown by analyses of gooseberries, in which the skin was found to contain 2.7 per cent acid and the pulp 1.8 per cent. To determine whether acid is formed when fruit is cooked, Sutherst boiled a mixture of nearly ripe gooseberries in water for about 30 minutes and then measured the amount of acid by trituration with sodium hydroxid solution. The boiled portion was found to contain less acid than the raw, probably because some of the acid was volatile and passed off with the steam.

As regards the effect of cooking on the kind and amount of sugar present, uncooked gooseberries were found to contain 1.2 per cent cane sugar and 5.8 per cent invert sugar. After boiling, no cane sugar was found while the invert sugar amounted to 6.9 per cent. This indicates that all the sugar undergoes inversion during cooking, the acid present bringing about the inversion in the usual way.

When fruits or fruit juices are cooked with sugar, the material very commonly solidifies or jellies on cooling, and this well-known property is taken advantage of in jelly making. In the case of some fruits, like the apple, the jelly-yielding material must be extracted from the fruit by cooking with hot water, while in the case of other fruits—the currant, for instance—this extraction with hot water is not necessary, as the expressed juice will produce a jelly. Heating the extracted or expressed juice is commonly considered a necessary step in jelly making, but some fruit juices will, on standing, jelly without heat, and laboratory tests have shown that jelly may also be obtained without the addition of sugar. Cooking and the addition of sugar are, however, important features in the practical consideration of jelly making, as they have a decided effect upon the yield, flavor, and keeping qualities of the resulting product.

Some fruits, like the ordinary varieties of pear, possess so little of the jelly-yielding material or possess it in such an unusual form that they do not yield a good jelly under ordinary household methods of treatment. The proportion of jelly-yielding material, like other constituents, varies with the stage of maturity, underripe rather than overripe fruit being best for the purpose.

The jelly-yielding bodies are known to be carbohydrates and have been called pectin, pectose, pectin bodies, or some similar name. They have been commonly grouped with the plant gums and similar carbohydrates, and the true nature of these materials has been the subject of a great deal of study.[a] At the present time the consensus of opinion seems to be that the pectins are composed of several of

[a] The Bureau of Chemistry of the Department of Agriculture has reported a number of important studies on the jelly-yielding constituents of fruit and an extended summary of previous investigations of the chemical nature of pectins and related questions. U. S. Dept. Agr., Bureau of Chemistry Bul. 94; Jour. Amer. Chem. Soc., 28 (1906), p. 200.

the simpler carbohydrates united to form a complex carbohydrate. In some fruits, like the apple, where the jelly-yielding material must be extracted with hot water, the pectin is apparently united with cellulose as a part of the solid pulp. As shown by the investigations of Bigelow and Gore at the Bureau of Chemistry, 40 per cent of the solid material of apple pulp may be thus extracted with hot water, and consists of two carbohydrates, one of which is closely related to gum arabic. That such carbohydrates as these should yield a jelly is not surprising when we remember that they are similar to starch in their chemical nature, and, as every one knows, starch, though insoluble in cold water, yields when cooked with hot water a large proportion of paste which jellies on cooling.

When fruits are used for making pies, puddings, etc., the nutritive value of the dish is, of course, increased by the addition of flour, sugar, etc., and the dish as a whole may constitute a better balanced food than the fruit alone. It is commonly believed that dishes in which fruits are cooked with the addition of sugar, butter, and a flour crust of some sort are less easily digested than simple rations of bread, butter, and fruit having an equivalent nutritive value. The large number of digestion experiments which have been made with various mixed diets do not indicate that there is any special difference between the two rations as regards thoroughness of digestion, but additional experiments must be undertaken before it can be said with certainty whether or not there are actual differences in the ease and rapidity of digestion.

In different countries opinions vary markedly regarding the relative wholesomeness of raw and cooked fruit. Thus, as has often been pointed out, the Germans use comparatively little raw fruit and consider it far less wholesome than cooked fruit. On the other hand, in the United States raw fruit of good quality is considered extremely wholesome, and is used in very large quantities, being as much relished as cooked fruit, if indeed it is not preferred to it. It has been suggested that the European prejudice against raw fruit may be an unconscious protest against insanitary methods of marketing or handling and the recognition of cooking as a practical method of preventing the spread of disease by fruit accidentally soiled with fertilizers in the fields or with street dust.

OVERRIPE, DECAYED, AND UNRIPE FRUIT.

Overripe fruit is often injurious, very probably because it has begun to ferment, and stale or partially decayed fruit is obviously undesirable for food purposes. In addition to a deterioration in flavor there is always the possibility of digestive disturbance if such fruit is eaten

raw. Of course, where apples are raised or where they are bought in large quantities for family use the thrifty housewife will sort them over and use for cooking the sound portions of those which have begun to decay. In such cases, however, the best available methods of storing should be followed and sorting should be done at frequent intervals, for if decay has proceeded very far the flavor is without doubt injured.

If fruits could be kept unbruised and with the skin unbroken, decay would be much delayed, as the mold spores, rots, etc., which cause decay, find their readiest entrance through broken skins. That mechanical injuries are the principal causes of decay was shown in a study of citrus fruits. When the skin of an orange or lemon is broken the blue mold finds access to the wound, and under favorable conditions of moisture and temperature develops readily and causes decay. An examination of hundreds of boxes of California oranges showed that a large percentage of all the fruit was made susceptible to such decay by accidental injuries to the skin in packing.

It is not at all strange that decayed fruit should have a decided characteristic odor and flavor when we remember that the decay is very commonly caused by fungi, especially molds and rots, which penetrate the pulp and grow and develop rapidly. The fungi live upon the cell contents, particularly sugars and proteids, and produce bodies of marked chemical characteristics, including odor and flavor. It is said that the most unpleasant effects are due to one of the common molds.

It is almost universally believed that green fruit is unwholesome and causes serious digestive disturbances, yet those who have been brought up in the country know that if illness had always followed eating it there would have been few well children in the community in the summer. Recognizing that green fruit may be a cause of illness at times and at other times apparently harmless, two German scientists have recently carried on extensive studies to ascertain the truth of the matter. Chemical analyses were made of fruits of varying degrees of ripeness, and studies in which green fruit was eaten in considerable quantities and under varying conditions were carried on with both animals and men. It appears from the results of the experiments that although unripe fruit is undoubtedly often harmful, particularly for children, the danger from such foods, especially green gooseberries, plums, pears, and apples, when eaten raw, is less than is commonly thought, and the effects depend in marked degree upon individual peculiarities.

The green fruit was found to contain the same chemical compounds as the ripe fruit, though in different proportions—that is, no chemical

element was found in the green fruit which was foreign to the ripe fruit and which could be considered in itself a cause of illness. The injurious effects of raw unripe fruit therefore, it appears, do not depend upon chemical constituents, but rather on the unusual proportions in which the constituents occur, and especially the large percentage of hard cell tissue, which, if imperfectly masticated, it will readily be seen, might be a source of digestive derangement. Possibly the excess of acid in the green fruit is also a cause of digestive disturbance. Cooked green fruit was found to be practically harmless, being especially palatable and wholesome when cooked with sugar.

The possibility of injury by bacterial contamination was considered, though the data available were not sufficient for final deductions. It is now well known that such diseases are usually caused by micro-organisms, so possibly the green fruit very frequently picked up beneath the tree is only an accidental carrier of the real cause of the digestive disturbances which may follow eating it.

HANDLING AND MARKETING FRUIT.

It is very important that fruits should be handled, stored, and marketed under sanitary conditions, as they are very commonly eaten raw, and not all persons are careful to wash them before serving. Fruit which has fallen to the ground may be readily soiled with earth, water, or other material which may contain typhoid or other bacteria. Indeed, cases of infection have been traced to fruits contaminated in this or some similar way and which were eaten raw without being washed. Investigations have also shown that fruits exposed to street dust and to other unfavorable conditions become covered with bacteria, which are always present in such dust-laden air, and may be possible sources of contagion. Flies and other insects are also known to be a source of dirt and contamination. Samples of fruit purchased in the street and examined by a German investigator (Ehrlich) showed tuberculosis bacteria and many other forms of micro-organisms, the number present varying considerably with different sorts of fruit.

Realizing that fruit exposed to street dust and insects may be a means of spreading disease, measures have been taken in Vienna to prevent such conditions, and fruit offered for sale must be covered with gauze or otherwise protected. In connection with the Vienna investigations microscopic examinations were made of the skins of plums and pears purchased at a much patronized fruit shop. It was found that the main source of contamination was dust containing fragments of stone from the street pavement and bits of horse manure.

As might be expected, Ehrlich found that those fruits with a firm dry skin, such as apples, did not furnish as good a lodging place for

bacteria and dust as fruits with a sticky surface, such as berries. Sticky dried fruits, such as dates, raisins, and figs, are also, as will be readily seen, favorable resting places for dirt and dust, as almost anything which the moving air currents lodge on the sticky surface will remain there. Fortunately, it is becoming a common practice to market such fruits in closed packages, usually of cardboard, which protect them to a great extent from dust and insects, so that the dried fruit, if clean in the first place, will remain clean.

It is often urged that washing fruit destroys flavor. On the other hand, skillful housewives maintain that if properly done the loss of flavor is inappreciable, and on the grounds of common cleanliness it would seem best to sacrifice a little flavor, if necessary, for the sake of removing filth and possibly dangerous bodies, even if the amount of dirt present is too small to be offensive to sight or taste.

Ehrlich, whose work has been cited, found that washing fresh fruit once thoroughly in running water was sufficient to remove the microorganisms present. If the fruit had been kept until the sticky surface was more or less dry, washing two or three times was found desirable. With apples and pears he recommends wiping with a clean dry cloth, followed by rinsing under the water tap. As is well known, berries, and other soft fruits sour and mold very readily if damp; they should therefore be washed just before they are served.

When fruit is washed the amount of material removed is small. In the case of soft fruits, like berries, with a surface skin which is very thin and easily broken, it is almost certain that larger quantities will be removed than with firm fruit.

An idea of the amount of material removed by washing fresh fruits, such as the apple, which is protected by a firm skin, may be gathered from some French experiments made to study the effects of washing apples used in cider making. Each apple in a 45-pound lot was washed separately in distilled water. The wash water took on a dirty black color and also had a disagreeable odor, and analyses showed that per 1,000 pounds of apples it contained about 0.3 pound total dry matter, the greater part of the dry matter being made up of sugar, with smaller amounts of pectin bodies, malic acid, and ash. The juice of washed and unwashed fruit was practically identical in composition. It is evident that the loss represented is too small to be of any practical account from the standpoint of economy, but even less than 0.3 pound of dirt per 1,000 pounds of fruit is something which all would wish to avoid when attention has once been directed to it.

On the whole, it seems fair to conclude that, notwithstanding the prejudice which many housewives have against the practice of washing fruit, it is unquestionably safest never to omit the precaution of

washing fruit which is to be eaten raw, unless one can be quite certain that it has not been exposed to possible contamination.

Metchnikoff [a] insists that there is danger of acquiring harmful intestinal parasites or their eggs from raw fruits and vegetables, particularly those liable to come in contact with the soil, and he believes that in all such doubtful cases these foods should be cooked, or at least scalded in hot water, before they are eaten.

Much of the dust and dirt and other unpleasant features might be avoided if our methods of handling and marketing fruit and other food products were at all comparable with our standards of sanitation in other lines and with what is easily possible. Improvements in present market conditions, however, can hardly be expected until the public demands them.

STORING FRUIT.

The manner in which fruits are transported and stored has a marked effect on quality. Low temperature retards after-ripening and decay and is the agent most depended upon at the present time, and refrigerator cars and cold-storage warehouses are now very common adjuncts of the fruit industry. It is said that a temperature of 31 to 32° F. is best for storing apples, pears, peaches, and oranges. Another authority gives 32° F. for cantaloupes and watermelons, 33 to 34° F. for cranberries, 34 to 36° F. for berries and bananas, 36° F. for lemons, and 35 to 40° F. for dried fruits. Tender fruits, it is said, will keep best if they are stored just when they are fully ripe, and sweet fruits will stand a lower temperature than sour fruits. The length of time fruits may be kept in cold storage varies with the kind, the degree of ripeness, the method of handling, and other conditions. With berries, it is a question of days; with peaches, melons, and other soft fruits, of weeks; and with apples and pears, of months.

Though pears of suitable varieties are frequently kept for winter use, apples are the fruit most commonly stored in the household, at least in the central and northern regions of the United States. For success a uniform temperature is essential, the nearer 32° F. the better. The air of the cellar or the storeroom must be moderately dry; that is, it must be moist enough to prevent fruit from shriveling and dry enough to be unfavorable to mold growth. The room must also be sweet and clean, as fruits will readily absorb unpleasant odors. Apples kept too near the turnip bin are very apt to have an unpleasant taste. It is also best to avoid drafts, especially when storing pears. Barrels and bins each have their advocates, but the consensus of opinion seems to be that both are satisfactory and the choice of one or the other simply a matter of convenience. If it is desired to keep

[a] The New Hygiene. London, 1906, p. 36.

apples or pears an unusually long time, the individual fruits should be wrapped in clean unprinted paper which is not too thick. A great many of the problems connected with the handling and storing of fruits have been studied in the Pomological Investigations of the Bureau of Plant Industry of this Department and by several of the agricultural experiment stations.

THE HYGIENE OF FRUIT.

Generally speaking, fruits are wholesome and palatable foods, yet it is not at all uncommon to find that one or more sorts can not be eaten by an individual. Thus many persons find that strawberries cause distress and many others that any acid fruit is a cause of digestive disturbance. Such cases are explained on the ground of some personal idiosyncrasy.

The extended use of fruit in the diet is certainly justified on the ground of palatability, food value, and esthetic considerations, but there are those who seek a further justification on the score of hygiene. It is commonly conceded that most fruits are laxative, and it seems probable that they owe this property to the considerable amount of water which they contain, to the salts in solution, or to the irritating crude fiber, small seeds, or other indigestible materials present, or to all these together. Man seems to crave and require some acid in his diet, and the citric, malic, and other fruit acids are undoubtedly wholesome.

The importance of fresh fruits and green vegetables in supplying the body with iron and other mineral matters is often spoken of, and it is true that the amount of iron, for instance, which many such foods contain is large in proportion to their protein content or their energy value. This means that if the ordinary diet does not supply enough of some mineral constituent it may be obtained by adding the fruit or green vegetable, which will give it without materially adding to the nutrients and energy of a diet already abundant in these respects.

Considerable bulk is an essential factor in the diet. If the foods eaten were of such a nature as to be almost completely absorbed, the large intestine would not readily empty itself and serious complications would follow. For this reason bulky foods, like fresh succulent vegetables and fruit, are of importance, as they usually contain a considerable proportion of indigestible matter.

In earlier times remarkable virtues or the opposite were commonly attributed to fruits, plants, precious stones, and other animate and inanimate objects, and it seems not improbable that the medicinal virtues which are often ascribed to various fruits in popular writings are survivals of this custom. No well-informed person would to-day

share the belief, once so widespread, that tomatoes are the cause of cancer, yet many apparently give credence to statements that certain fruits are a satisfactory food for brain workers, while others must be avoided. At any rate, such statements are often found in print. In general, it may be said that very few investigations have been made which indicate that the different fruits possess specific medicinal qualities. Those which contain an abundance of sugar are naturally excluded in a large measure from the diet of diabetics, while there are other conditions in which acid fruits are conceded to be undesirable.

To the juice of acid fruits like the lime, lemon, orange, pomelo, or "grape fruit," and the kumquat (the small orange which is eaten entire, both skin and pulp) hygienic properties are commonly attributed, and there is reason to believe that this reputation is deserved. Such fruit juices stimulate the appetite and are beneficial in other ways. The bitter principle in the pomelo is commonly said to be of value medicinally, perhaps because it suggests the bitter flavor of quinine, but so far as can be learned the real value of this bitter quality is a matter of opinion rather than of experimental study.

Some fruits, notably the tropical papaw and the pineapple, contain very active ferments. The ferment present in the papaw is separated in commercial quantities and used as a digester of nitrogenous materials. Perhaps it is quite natural that much stress should have been laid on the ferment present in the pineapple and that this fruit should be recommended for use at the end of a meal, so that its ferment may aid the body in digesting food. It should be remembered, however, that the body in health does not need artificial aid in performing its normal functions and that for digestive disturbances it would be wiser to seek competent medical advice than to depend on the casual use of pineapple or other plant ferment, especially when it is remembered that there is great doubt as to the efficacy of any ferments introduced artificially into the stomach.

Fortunately there are so many other good reasons for using fruits that we have little need to base our use of them in quantity on supposed medicinal virtues.

EXTENT OF THE FRUIT INDUSTRY IN THE UNITED STATES.

As shown by statistics based on the results of dietary studies of nearly 400 American families, fresh fruits make up 3.8 per cent of the total food and supply 2.5 per cent of the total carbohydrates. Similarly dried fruits furnish 0.6 per cent of the total food and 1.2 per cent of the total carbohydrates. The values for fruits as a whole, therefore, are 4.4 per cent of the total food material and 3.7 per cent of the total carbohydrates. These figures are not large in themselves, yet compare favorably with the values for different groups of vege-

table foods. Thus the same compilation shows that vegetables, other than legumes, potatoes, and sweet potatoes, furnish 6.2 per cent of the total food and 1.7 per cent of the total carbohydrates of the average American diet.

Besides the fruit consumed at home a great amount is exported, and there is no doubt that fruit growing is one of the important agricultural industries of the United States, and one which is rapidly developing. The report of the Twelfth Census[a] shows that the total value of fruit grown in contiguous United States in 1899 was in round numbers $131,099,000, of which orchard fruits made up $83,751,000, grapes, $14,090,000, small fruits $25,030,000, and oranges, lemons, and other subtropical fruits, $8,228,000. Of the individual States, California and New York were the greatest fruit producers, the large acreage of orchard fruits and grapes in these States being prominent factors in the problem.

The progress of fruit production during the decade between the last two censuses is indicated by the gain in the number of orchard fruit trees; the number of these trees in 1900 was 90 per cent more than the number in 1890.

Of orchard fruits the apple has decidedly the first place, 55 per cent of the total number of fruit trees in the United States in 1900 being apple trees, and this fruit making up 83 per cent of the total number of bushels of orchard fruit produced. Judged by the number of trees under cultivation the greatest increase has been found in the case of plums, apricots, and pears, though peaches and cherries also have shown large gains. Of small fruits strawberries, as might be expected, were the most important crop, and raspberries next, 257,438,000 quarts of strawberries and 76,628,000 quarts of raspberries having been grown in 1899.

In the case of canned and preserved fruits and similar goods the Census returns[b] give later figures than those quoted for fresh fruits. The total value of the canned fruit produced in 1904 was in round numbers $11,644,000, dried fruit, $15,665,000, and other fruit products $5,571,000, or a total of $32,880,000. Of the individual canned and preserved fruits the peach ranked first, the value of the peaches canned in 1904 being $3,894,000, with canned pears at a value of $2,192,000 ranking next.

Considering dried fruits, raisins ranked first, the total value of the raisin crop in 1904 being $6,349,000.

In 1906 the United States imported prepared, preserved, and dried fruits to the value of $5,337,000. The value of the domestic exports of dried, canned, and preserved fruits was $7,635,000.

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[a] Bur. of the Census [U. S.] Rpts., vol. 6 (Agriculture, pt. 2), p. 599.

[b] Bur. of the Census [U. S.], Bul. 61, p. 3.

The statistics which have been quoted show a decided gain in the American fruit industry, both as regards fresh and preserved fruits, and there are reasons for believing that even the present development represents only a beginning. This being the case, it is easy to understand why the agricultural experiment stations have devoted so much of their time to the study of fruit products, the marketing of fruit, and related problems, and why the place of fruit and fruit products in the diet and their value as food should be regarded as an important subject for investigation.

CONCLUSIONS.

In general, it may be said that fruits are wholesome, palatable, and attractive additions to our diet, and may be readily made to furnish a considerable part of the nutrients and energy required in the daily fare. Fresh fruits are dilute foods and closely resemble green vegetables in total nutritive value, but dried fruits and many preserves, etc., are much more concentrated, comparing favorably with some of the cereals and other dry vegetable foods in the amount of total nutrients and energy which they supply per pound. The characteristic chemical constituents of fruits are carbohydrates, and so they are naturally and properly used in a well-balanced diet to supplement foods richer in protein, as cereal grains, legumes, nuts, eggs, dairy products, meats, and fish. Fruits contain considerable mineral matter, and as they are dilute foods they may be added to the diet to supply iron and other mineral constituents without unduly increasing the supply of protein and energy. Since they are bulky and often contain fairly large proportions of indigestible material, fruits stimulate what might otherwise be a sluggish intestine. Intelligently used, fruits are a valuable part of a well-balanced diet and may well be eaten in larger quantities than at present.

FARMERS' BULLETINS.

The following is a list, by number, of the Farmers' Bulletins available for distribution. The bulletins entitled "Experiment Station Work" give in brief the results of experiments performed by the State experiment stations. Titles of other bulletins are self-explanatory. Bulletins in this list will be sent free to any address in the United States on application to your Senator, Representative, or Delegate in Congress, or to the Secretary of Agriculture, Washington, D. C. Numbers omitted have been discontinued, being superseded by later bulletins.

22. The Feeding of Farm Animals. Pp. 40.
24. Hog Cholera and Swine Plague. Pp. 16.
27. Flax for Seed and Fiber. Pp. 16.
28. Weeds: And How to Kill Them. Pp. 30.
30. Grape Diseases on the Pacific Coast. Pp. 15.
32. Silos and Silage. Pp. 30.
33. Peach Growing for Market. Pp. 24.
34. Meats: Composition and Cooking. Pp. 31.
35. Potato Culture. Pp. 24.
36. Cotton Seed and Its Products. Pp. 16.
42. Facts About Milk. Pp. 32.
44. Commercial Fertilizers. Pp. 38.
47. Insects Affecting the Cotton Plant. Pp. 32.
48. The Manuring of Cotton. Pp. 16.
51. Standard Varieties of Chickens. Pp. 48.
52. The Sugar Beet. Pp. 48.
54. Some Common Birds. Pp. 48.
55. The Dairy Herd. Pp. 30.
56. Experiment Station Work—I. Pp. 30.
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60. Methods of Curing Tobacco. Pp. 24.
61. Asparagus Culture. Pp. 40.
62. Marketing Farm Produce. Pp. 31.
63. Care of Milk on the Farm. Pp. 40.
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77. The Liming of Soils. Pp. 24.
78. Experiment Station Work—V. Pp. 32.
79. Experiment Station Work—VI. Pp. 27.
80. The Peach Twig-Borer. Pp. 16.
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82. The Culture of Tobacco. Pp. 22.
83. Tobacco Soils. Pp. 23.
84. Experiment Station Work—VII. Pp. 32.
85. Fish as Food. Pp. 32.
86. Thirty Poisonous Plants. Pp. 32.
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91. Potato Diseases and Treatment. Pp. 15.
92. Experiment Station Work—IX. Pp. 30.
98. Sugar as Food. Pp. 31.
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98. Suggestions to Southern Farmers. Pp. 48.
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100. Hog Raising in the South. Pp. 40.
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102. Southern Forage Plants. Pp. 48.
103. Experiment Station Work—XI. Pp. 30.
104. Notes on Frost. Pp. 31.
105. Experiment Station Work—XII. Pp. 32.
106. Breeds of Dairy Cattle. Pp. 48.
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110. Rice Culture in the United States. Pp. 28.
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113. The Apple and How to Grow It. Pp. 32.
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118. Grape Growing in the South. Pp. 32.
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121. Beans, Peas, and Other Legumes as Food. Pp. 38.
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